RIVERS OF THE PAST: CREATORS OF OIL

G.V. Obediyentova

(NASA-TT-F-15974) RIVERS OF THE PAST: CREATORS OF OIL (Kanner (Leo) Associates) CSCL 08G
N75-10517
Unclas
G3/42 52665

Translation of "Reki proshlogo -- sozdateli nefti," Priroda, No. 7, 1974, pp. 28-37

Reproduced by
NATIONAL TECHNICAL INFORMATION SERVICE
US Department of Commerce
Springfield, VA. 22151

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546 OCTOBER 1974

STANDARD TITLE PAGE

1. Report No. NASA TT F-15,974	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle RIVERS OF THE PAST:CREATORS OF OIL		5. Report Date October 1974 6. Performing Organization Code
7. Author(s) G. V. Obediyentova		8. Performing Organization Report No. 10. Work Unit No.
9. Performing Organization Name and Address Leo Kanner Associates Redwood City, California 94063		11. Contract or Grant No. NASw-2481 13. Type of Report and Period Covered Translation
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration, Washington, D.C. 20546		14. Sponsoring Agency Code

15. Supplementary Notes

Translation of "Reki proshlogo -- sozdateli nefti," Priroda, No. 7, 1974, pp. 28-37

16. Abstract The article discusses and illustrates, with photos and maps, the discovery, mapping, and changing flows of the ancient rivers of the Russian plain. The matter presented is intended to demonstrate that many of the known oil deposits of European Russia were formed in the deltas and shallow water shelves of the paleorivers. Changes in the courses and deltas of the paleorivers are explained by tectonic movements and sea advances and retreats affecting the Russian platform. It is indicated that long-term stability in position of river deltas and shallow marine and lake waters, with subsequent prolonged submergence of alluvial and delta sediments, are most promising for formation of oil.

PRICES SUBJECT TO CHANGE

17. Key Words (Selected by Author(s))	18. Distribution Statement Unclassified-Unlimited		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages	22. Price

RIVERS OF THE PAST: CREATORS OF OIL

G.V. Obediyentova

Dedicated to the memory of Samuila Yevel'yevicha Geller. /29*

Several years ago, the well-known geographer and specialist in the Caspian region, S. Ye. Geller, complained that modern geomorphological research had not gotten the significance of ancient rivers in formation of inflammable mineral deposits from the long-continued work of the outstanding Soviet geologist, B. L. Lichkov. At the same time, there still was not enough factual material to be able to discuss this convincingly with large numbers of readers. Years of tedious work were required, before it would be possible to engage in such a discussion, but Samuil Yevel'yevich was not fated to know this. My work in study of the ancient valley of the Volga was, as it were, execution of the will of S. Ye. Geller for continuation of this interesting area of geomorphology

Buried Valleys

Water and Petroleum

At first glance, this combination appears to be paradoxical. Actually, rivers flow over the surface of the Earth and petroleum comes from its interior. However, there is a perfectly specific relation here. It is known that, by studying the history of formation of the relief of the Earth, geomorphologists are revealing, in particular, the direction of ancient hydrographic networks, for various time intervals of the geological past. By comparison of these data with known petroleum deposits, the

---

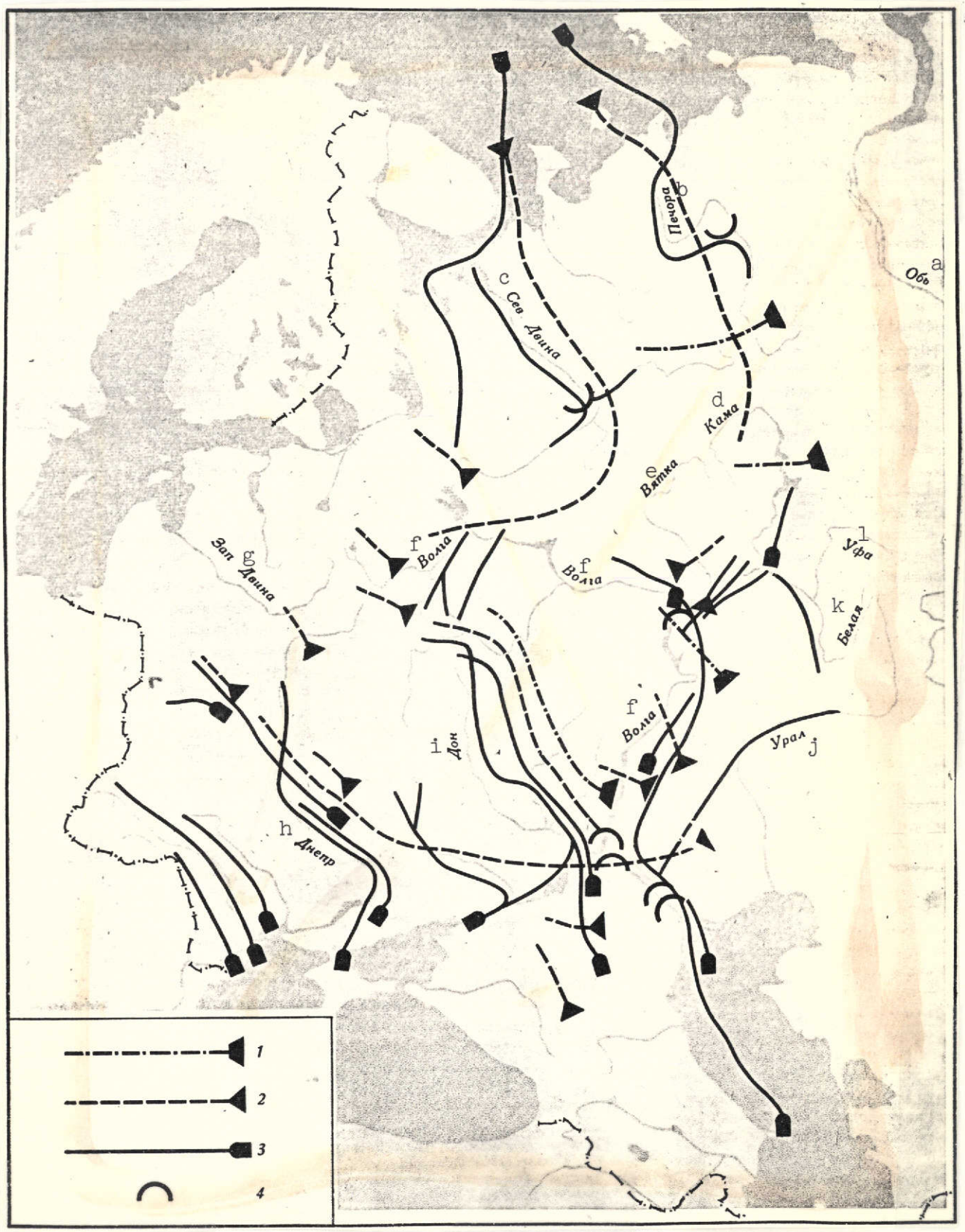
* Numbers in the margin indicate pagination in the foreign text.

Glafira Vital'yevna Obediyentova, senior scientific colleague, Institute of Geography, Academy of Sciences, USSR, geomorphologist. In recent years, she has been occupied with the problem of formation of river vallys and reconstruction of paleorivers.

connection between the activity of rivers and the process of accumulation of oil-bearing sedimentary strata is striking. This approach is especially interesting, by the fact that it allows the framework of investigation and prediction in the search for petroleum to be enlarged.

We easily find traces of ancient rivers at great depths, in the form of alluvial branches. In other words, in the distant past of the Earth, rivers existed as they do now. However, we now see former river systems fixed /30 only in ancient sediments. In the strata filling ancient valleys, from bottom upward, replacement of river (alluvial) deposits by lake is observed and, still higher, by marine. Thus, the alternation of dry land and sea is followed in a vertical cross section of a sedimentary stratum. The spatial distribution of dry land and seas in different geological periods reflects the paleogeographic maps, compilation of which was begun by A. P. Karpinskiy in the last century. As soon as the sea retreated (regressed) from some portion of the Earth's surface, rivers appeared in the reclaimed territory.

Deepening its bed, a river washes away the surface of the Earth, carrying the washed-out particles downstream. Alluvial masses are carried away to the receiving basin, to the lake or sea into which the river flows. A part of the alluvium remains in the river valley developed, in the form of alluvial plains or terraces. In the lower terrace or flood plain, accumulation of



[Caption and key on following page]

Caption and key to map, p. 3

Direction of flow and location of deltas of various ages on the Russian plain. Depressions opening south and north contained the rivers and their deltas in the Paleozoic (1), Mesozoic (2) and Cenozoic (3). It is clear that shifts of ancient deltas have occurred in the depressions over this time. At constant flow, the positions of river mouths have changed. Migration of the deltas, depending on the position of the shoreline of the receiving basin, is characteristic of each geological era. Shifting of the river mouths is most characteristic in the Cenozoic: the mouth of the Paleodnepr migrated from Pripyat (Pliocene) to the Black sea (Quaternary period), the mouth of the Paleodon, from the Yergen' (Miocene) to the Predkavkazye (Pliocene), the mouth of the Paleovolga from Kazan to Baku (Pliocene). The mount of the pre-Akchagylsk Volga is represented near the Apsheronskiy peninsula, and the position of the mouth in the period of the greatest extent of the Akchagylsk transgression is near Kazan. The mouth of the Volga shifted at nearly the same rate during the Quaternary period (4). Thus, only the mouths of rivers entering the Mesozoic sea are found in the center of the Russian platform. A large number of river mouths of later periods found is characteristic of the marginal sections of the platform. They are located most densely in the Eastern Depression, within which the rivers have evolved their activities in succession, from the Paleozoic to our times. The principal petroleum reserves of the Russian platform are concentrated here.

Key:
a. Ob'
b. Pechora
c. Northern Dvina
d. Kama
e. Vyatka
f. Volga
g. Western Dvina
h. Dnepr
i. Don
j. Ural
k. Belaya
l. Ufa

---

alluvium takes place before our eyes: during the spring thaw of the snows, the river level rises; water, going out of the banks, inundates the flood plains; the muddy spring waters leave a thin warp on the flood plain surface, building up a layer of alluvium. In this manner, the history of development of the river valley can be scanned in the alluvial stratum.

In the course of formation of the relief of an alluvial plain, which formerly was a flood plain, the level of inundation by flood water may have been raised up. Thus, alluvial terrace steps are created in the river valley. With tectonic sinking of the surface, the terrace staircase gradually is covered by younger alluvium and products removed from the valley slopes. If this sinking continues for a long time, the valley is covered with sea water. Marine deposits level the relief of the submerged surface. The valley becomes buried.

Let us examine the material, which we have available for the Volga, and attempt to demonstrate that the ancient Volga worked to create the so-called productive strata, i.e., containing petroleum. As early as the 1940's, buried valleys were discovered between the mountain peaks of the Zhigulya and at the feet of them, under the bed of the modern Volga. Akchagylsk marine (Pliocene) deposits were found between the ancient buried alluvium and the channel alluvium of the modern Volga [1]. Consequently, an inlet of the sea was located here, between the times of existence of the ancient and modern rivers.

In the 1950's, a continuation of the river valley below the Zhigulya hills was revealed by bore holes in the Kuibyshev Volga region, at a depth of 200-300 m below sea level. The bottom of the buried valley cut into the Zhigulya, into Carboniferous age limestone and, further south, into Mesozoic rock. This means that traces of the post-Mesozoic river had been discovered. It was difficult to determine the start of the existence of the ancient river more precisely, whereas the time of its burial is known: the alluvial and lake deposit strata filling the valley were covered with marine deposits of Akchagylsk age. The valley was called pre-Akchagylsk, from this indicator [2].

Thus, the pre-Akchagylsk river flowed in a direction parallel to the Volga, 80-100 km to the east of the modern river channel.

And where was its source? Where was its continuation? Years passed before the ancient river and its main tributaries could be sketched on the surface. Deposits of it were revealed by numerous bore holes. Many scientists (A.V. Vostryakov, S.G. Kashtanov, N.V. Kirsanov and others) were occupied with study of this stratum filling the ancient channel. The hidden river system, repeating the river basin of the modern Volga on the surface, was gradually discovered. However, the paleorivers were located somewhat to the west of the modern rivers. These were the Paleovolga, with the Paleokama, Paleosamara, the previously discovered northern Zhigulya River and other tributaries. The buried channel of the main river was successfully traced from the latitude of Gor'kiy to Astrakhan.

And now the main question is: where is the mouth of the main pre-Akchagylsk river to be found? Judging from the depth of the channel revealed (600-800 m below sea level), it should be located considerably south of the modern Volga delta. If the bed of the Paleovolga was discovered hundreds of meters deeper than sea level, obviously, the mouth of the main river must be sought in the southern, deep-water basin of the Caspian Sea. But how is this?

Let us turn to the facts.

The Homeland of Baku Petroleum

The petrographer V. P. Baturin, studying the deposits of the Apsheronskiy peninsula near Baku in 1937, discovered that components transported from the Russian plain predominate in rock containing petroleum [3]. Further study of the petrographic composition of the rock, included in this productive stratum, caused doubt as to the correctness of this conclusion. Many geologists proposed that the principal ablation of the clastic material forming the productive stratum of Apsheron originated in the Caucasus. However, the composition of the stratum also

includes minerals, forming the rock of the uplifted zone of the Caspian floor ("threshold"), dividing the southern deep-water and middle parts of the sea. These minerals could only enter the productive stratum, in case, during the formation of the latter at the location of the modern Caspian Sea (with the exception of its southern, deep-water basin), were dry.

The surface of the Caspian dry land was eroded by the river, yielding a mass of loose alluvium in the closed Priapsheron basin (the so-called Balakhan Lake). Of course, the large river had a large drainage area. This was the pre-Akchagylsk Volga, the outlines of the basin of which are reminiscent of the basin of the modern river. South of Astrakhan, the buried Pliocene bed of the Volga is noted very deep in the western part of the Caspian Sea.

According to the data of numerous investigators of the land along the Volga, the paleoriver bed had the nature of a canyon, in which only insignificant layers of alluvium were preserved. A large part of it was carried out beyond the river valley. The /31
energetic cutting of the Paleovolga was caused by uplift of the crust of the Earth. Earlier, in the Cimmerian-Balakhan age, the peaceful flatland river, deepening its bed, carried alluvium, formed during the Miocene and early Pliocene, out of its valley. Remnants of the latter were preserved only beyond the valley of the pre-Akchagylsk Volga. This is a mass of alluvium carried away by torrents, deposited only in the receiving basin, the Balakhan Lake.

Thus, geological and paleogeomorphological research confirmed the conclusion of V.P. Baturin, on the basis of petrographic analysis.

Transport of alluvium to the southern basin of the modern Caspian stopped in the late Pliocene, when sinking of the land along the Volga began (it was caused by plutonic processes, manifested,

Formation of oil-bearing rock begins far from the sea, in small streamlets. Spring melt waters carry away soil particles from the fields and forests. The muddy waters contain much soil organic matter. Gathering into streams, the spring waters carry this wealth into the rivers. During the entire time, the mechanism of sediment transport by the rivers was the same as in this streamlet near Moscow in the early spring. TASS photochronicle.

as N.S. Shatskiy pointed out, in a meridional strip from the mouth of the Kama to the south shore of the Caspian) [4]. Deposition of alluvium within the valley began, following the change in the direction of motion. It is evident that the regime of the pre-Akchagylsk Volga River was soon replaced by a lake regime: within the younger (so-called Kinel') deposits, filling the valley, lake deposits predominate. Upward along the cross section, the latter are gradually replaced by marine regimes. The salt waters of the Akchagylsk Sea, advancing into the depression along the Volga,

penetrated to the lower course of the Kama. The Volga and the Kama discharged into this gulf, each one independently. The erosion process was interrupted for a long time below the mouth of the modern Kama. Marine deposits, covering the alluvial (river) and lake ones, completed filling of the pre-Akchagylsk Volga valley.

Paleogeomorphological reconstructions confirm the newest data of petrographic analysis. The Soviet geologist Ye.Ye. /32
Milanovskiy, noting the role of erosion from the Russian plain in the process of formation of the productive stratum, considers that a decrease in the roles of the northern supply sources took place, with the beginning of accumulation of the Kinel' suite in the Volga valley. This was the time of accumulation of the upper part of the productive stratum, the so-called Syrakhan suite. Subsequently, the genetic connection of the productive stratum with the Volga alluvium stopped. It accumulated in the Prikaspiyskiy depression and more northern regions. At the end of the Pliocene and during the Pleistocene, the Volga delta shifted between the mouth of the Kama and its modern location.

Thus, the ancient Volga, with its numerous tributaries, undoubtedly worked on creation of the productive stratum. The modern Volga carries a mass of humus, washed out of the soil cover of the Russian plain by the rivers, to its delta and the northern shallow-water basin of the Caspian, together with mineral particles. This alluvium has created the fertile soil of the Volga-Aktyubinsk flood plain and the Volga delta. The orchards and melon fields cultivated on these soils feed the land along the Volga and the center of the European part of the country with their fruits. The Paleovolga carried this same humus to the Balakhan Lake, providing one of the conditions for oil-formation. However, the humus is an organic formation. And petroleum? Being a geomorphologist, in study of the paleohydrography, I did not set the goal of solving the problem of the genesis of petroleum. However, the regularities revealed by paleohydrographic analysis

force it to be connected to the point of view of its biogenic origin.

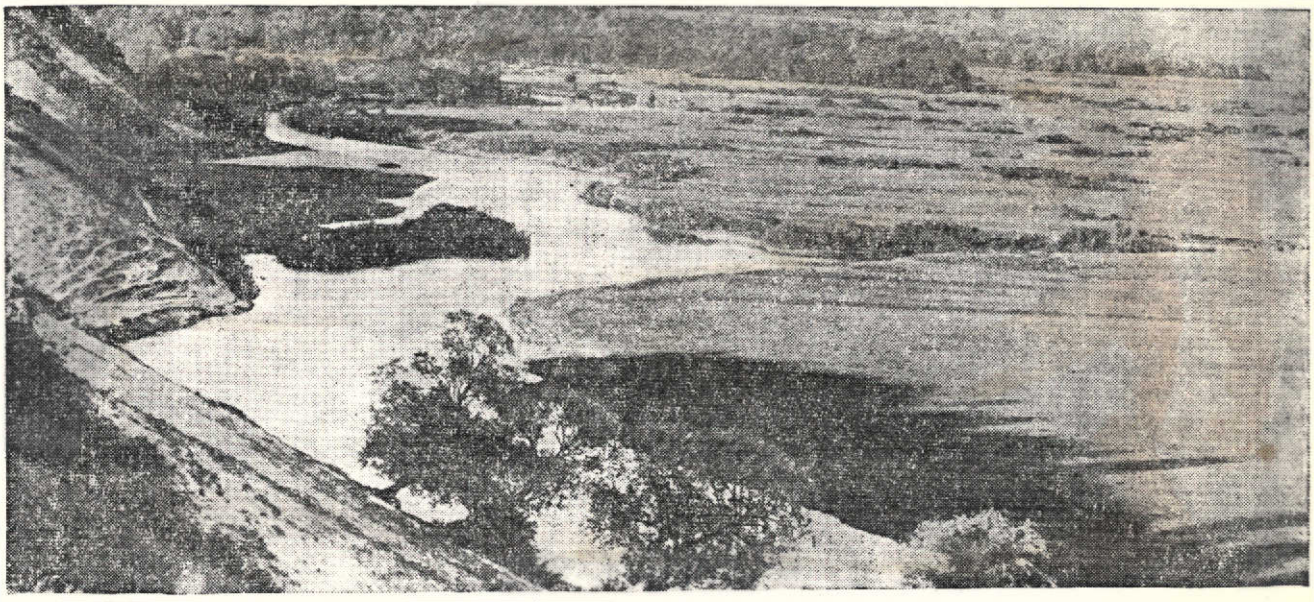
Ancient Depressions of the Crust of the Earth and River Deltas

All the large rivers of the Russian plain, ancient and modern, are confined to depressions in the crust of the Earth, and they flow in the direction of the maximum sinking of them. Depression of the crust of the Earth in the regions of river deltas and shelves have facilitated accumulation of thick sedimentary, including oil-bearing, strata.

The valleys of the paleorivers have caused a pattern in spatial location of minerals, which has been noted by I.M. Gubkin. The accumulation of bauxites, the crusts of lateritic weathering, are confined to erosional depressions in the zone of river washing nearer to the river sources. Many coal deposits are confined to the valleys of paleorivers, including the Donets basin. In the regions of deltas and receiving basins, as we have seen with the example of the Baku deposit, oil-bearing rocks have formed.

The thought of the connection of petroleum formation with accumulation of thick strata of delta sediments was first expressed in the domestic literature by B.L. Lichkov [5]. He noted that the initial materials of petroleum are accumulated in regions of subsidence and that all petroleum deposits created in different geological periods are located on the boundary of sea and dry land. Tremendous thickness of the rock accompanying and covering petroleum deposits is characteristic of just these territories.

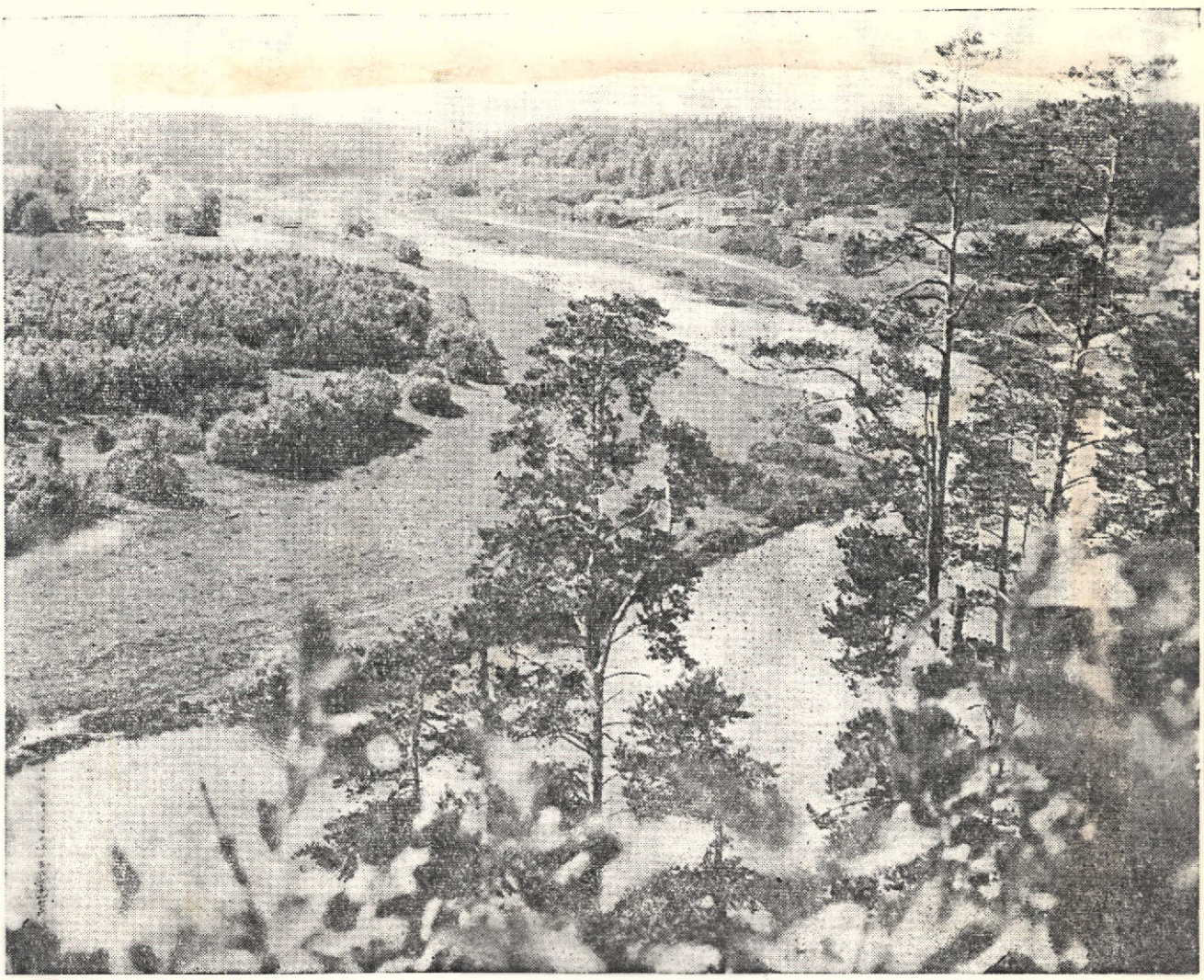
The front of the work in this area has expanded recently, and new proofs have been obtained on the tremendous role of river deltas and shelves in accumulation of sediments, containing solid, liquid and gaseous hydrocarbons [6]. Moreover, delta deposits,



Annual burdens convert the flood plain into a level surface, with depressions (cut-off meanders), where the water remains, even after the river level has decreased to the low water level. The cut-off meanders bubble with life. Vegetatable and animal remains, together with mud, drop to the bottom. Within the flood plain alluvium, there is much soil buried in sand, and many muddy, humus-containing layers. All this is material for future petroleum deposits. Psyel river flood plain.
TASS photochronicle.

owing to alternation of clayey and sandy layers, are the containers of migrating oil and gas.

This idea is confirmed in reconstruction of paleodeltas of various ages of the Russian plain. The deltas are concentrated in the eastern half of the Russian plain, in the zone of the Eastern Depression, laid down as early as the Paleozoic. In periods of transgression of the sea inlets formed into the depression, straits connecting the northern and southern seas were formed here repeatedly. During periods of retreat of the sea, rivers flowing into these straits were directed along the strait, /34
following the retreating sea. The Pechora, Kama and Second Baku



Annual burdens raise the level of the flood plain. With time, it stops being flooded and is converted into an unfloodable terrace. In place of meadows, forests become established and, in the southern zone, the meadow is replaced by steppe grasses. The terraces of large rivers are transformed into fertile fields. A meadow flood plain and two levels of terrace covered with forest are seen in the photo, in the valley of the Ruza river. Upon being buried, these deposits can lead to the formation of branch deposits of petroleum.
TASS photochronicle.

petroleum deposits, the Saratov gas fields and the northern Caucasus and Baku deposits are confined to this strip of paleo-delta concentrations.

A second strip of paleodelta distribution corresponds to the Pripyat and Dnepr-Donets depressions. The sea advanced along this depression from the southeast. During periods of its retreat, the rivers flowed toward the southeast. The changeability and location of the sea shoreline caused migration of the deltas. The Pripyat-Dnepr and northern Caucasus oil deposits are confined to the places where the deltas existed the longest. Deltas of paleorivers, flowing from Moscow along the Ryzan-Saratov depression, including the so-called Yergen' River, which created the delta-marine deposit of the Yergen'insk stratum and which gradually moved its delta to the Sea of Azov, also are concentrated in the Predkavkazye. All these deposits can be considered to be potentially oil-bearing.

However, oil deposits are far from being confined to each paleodelta. More than that, some regions of paleodelta concentrations are recognized to be unpromising. What is this exception to the rule or absence of pattern?

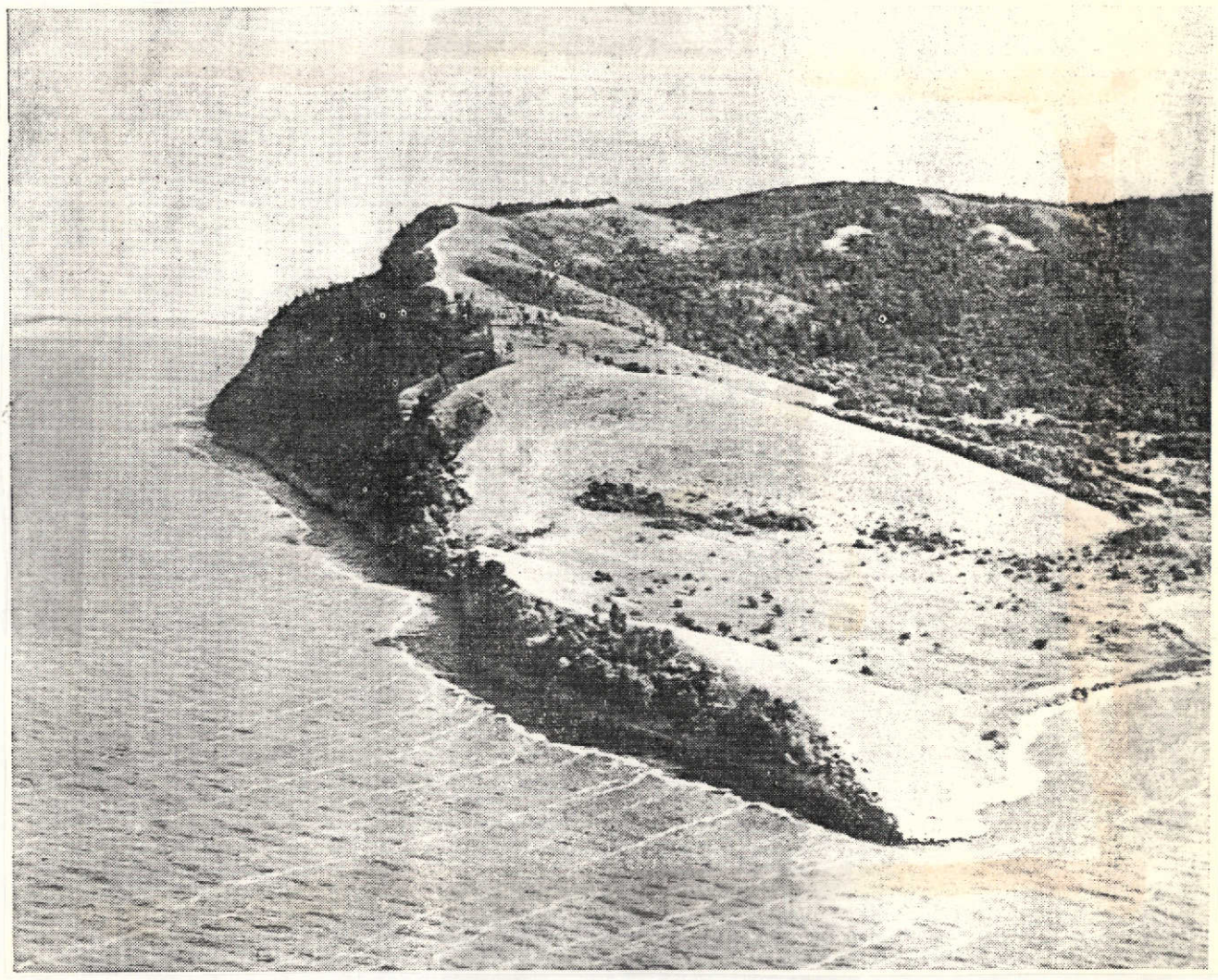
Astonishing Stability

Rivers have always existed. There was dry land, and there were rivers. Forming a complex network, rivers flow together, and the main river, taking all the inflows, flows out into a lake or sea. Areas occupied by seas, the configurations of reservoirs and the outlines of sea and lake shorelines were changeable over time. The 2-m lowering of the level of the Caspian Sea in the twentieth century has caused a decrease in area of the northern shallow-water part of it, reducing the length of the shoreline and completely drying out the Komsomol Gulf. In this case, the Volga delta has advanced only a little to the south, retaining its former location. Rivers have behaved in the same way, with large changes in the ratio of the area of dry land and sea. During a retreat of the sea, the mouths of the rivers have

moved along behind the retreating sea; during transgressions, the rivers became shorter, because of a lower flow. A paleohydrographic analysis reveals a highly significant fact: the property of a river, during recovery in a period of retreat of the sea, of preserving the same direction of flow, which it had before the transgression. Conservatism of river flow was noted still earlier by B.L. Lichkov. He wrote: "... once there were rivers on these continents, they inevitably had to be located, not in new places, but in those, which tectonics and erosion had already once prepared""[7].

This stability in flow is caused by the fact that the main large rivers are confined to depressions in the Earth's crust. The latter, as a rule, experience persistent sinking. The rivers, lengthening and shortening, moving the delta along the depression, create a sedimentary deposit of considerable thickness within it. These strata can be considered to be potentially oil-bearing. When a delta is in a stationary position for a long period of time, strata accumulate of such great thickness that, of the promising ones, they become oil-producing. The thickness of the parent oil stratum is determined, not only by the length of time over which it accumulates, but by the dimensions and volume of the material brought in. The rate of accumulation of sediments is closely connected with the climate, strength of the rock being eroded and the flow rate of the river. To determine the amount of solid material carried away by a river in past geologic periods is a difficult matter. It is considerably easier to determine the direction of movement of the crust of the Earth and change in direction of movement in time and space.

By analyzing the ancient hydrographic network, we ascertained that the rivers sometimes overcame obstacles in their paths, which arose, in the form of local uplifts, by eroding or bending around them, and that they flowed unchangeably in the direction of



Molodteskiy Kurgan in the Zhigulya. It is now flooded with water. A dam raised the level of the Volga (on the left) and its tributary, the Usa (on the right). The northern Zhigulya river flowed past the foot of the tumulus in the Pliocene. By undercutting the steep northern slopes of the Zhigulya, it made the latter rocky. Opposite the Volga, the slopes fall in soft, steep slopes to the ancient valley, filled with alluvium and Akchagulsk marine sediments. Oil deposits were discovered in the 1940's in the Yablonova and Zol'noye valleys, which are similar to the Molodetskiy. The petroleum industries of the Zhigulya played a major role in supplying our army with petroleum during the serious months of the battle on the Volga. TASS photochronicle.

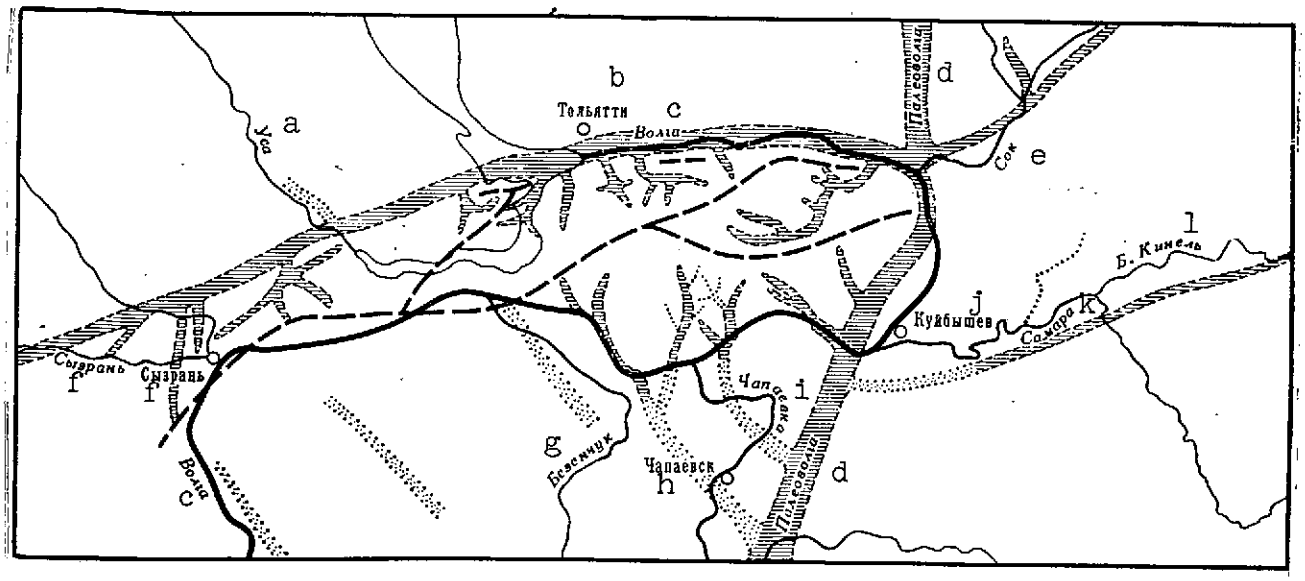
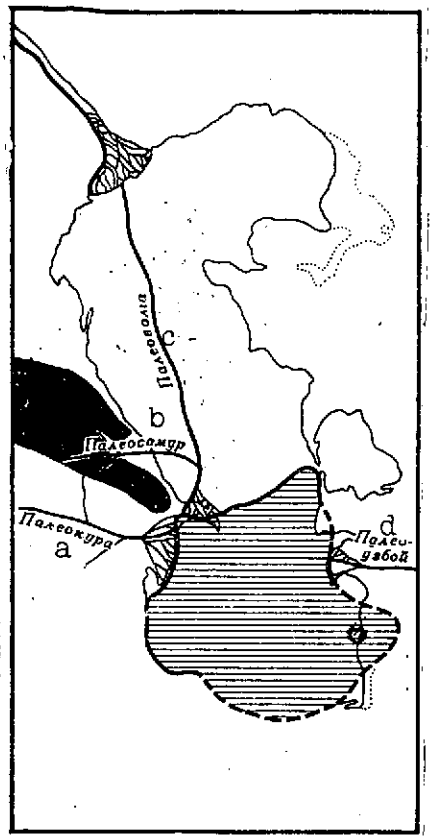


Diagram of Samara bow water network. Traces of the paleorivers of the Zhiguyla massif, in the form of alluvium, covered with marine Akchagylsk deposits, were discovered, as a result of drilling (cross hatching). In places where there are not drilling data, sections of buried valleys are indicated provisionally (by dots). Along the foot of the Zhigulya mountains, in the northern part of the Samara bow, a large northern Zhigulya River flowed sometime, the source of which was located to the west of Syzran' (the main watershed is noted by dashed lines). This river flowed into the Paleovolga near the mouth of the modern Sok, in the Zhigulya gates. The Paleovolga flowed from north to south.

Key:
a. Usa
b. Togliatti
c. Volga
d. Paleovolga
e. Sok
f. Syzran'
g. Bezenchuk
h. Chapeyevsk
i. Chapeyevka
j. Kuibyshev
k. Samara
l. Bol'shoy Kinel'

areas of persistent sinking. Movements in the central sections of /36 the Russian platform were less persistent. Large-scale rearrangement of the structural lay-out led to change in the direction of

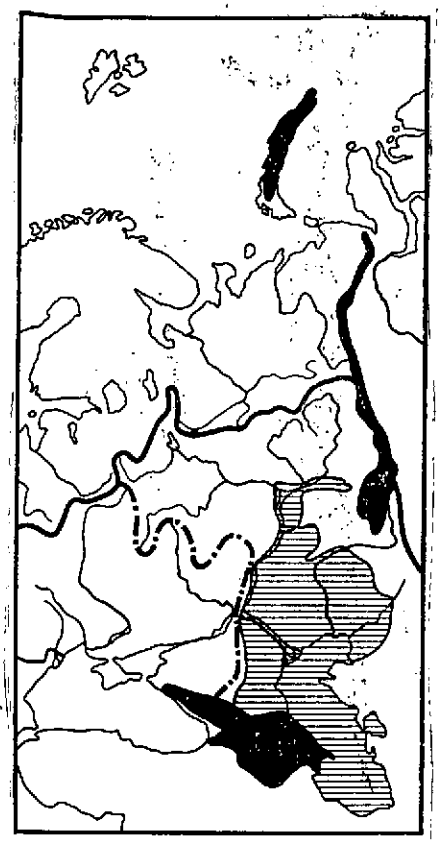


Balakhan Lake (cross hatched) occupied the southern basin of the Caspian in the middle Pliocene (according to V.P. Baturin, 1937). Sediments, which had created the productive oil-bearing stratum, were transported in by rivers from the Caucasus, the basins of the Paleosamur and Paleokura, from Kopetdaga, by the basin of the Paleo-uzboy and, from the Russian plain, by the Paleovolga basin.

Key: a. Paleokura;
b. Paleosamur;
c. Paleovolga;
d. Paleouzboy

flow. Up to the middle Carboniferous, rivers draining the central part of the Russian platform, the zone of the so-called Moscow syneclise (depression), flowed to the west, into the sea existing in the territory of modern western Europe. In the middle Carboniferous, an uplift in the region of the modern Valday uplands and sinking, appearing more intensely in the eastern part of the Moscow syneclise, caused the generation of a flow to the east and northeast. Rivers flowing from the Baltic shield and the marginal sections of the syneclise flowed either into the sea existing in the axial zone of the latter or into the northern seas. The watershed between the northern and southern rivers was located somewhat to the south of Moscow. At the Mesozoic-Cenozoic boundary, a second, latitudinal watershed began to form, in the location of the northern Urals. Rivers draining the central part of the platform, the basins of the modern upper Volga and Oka made their ways to the southeast and entered the lower Volga system.

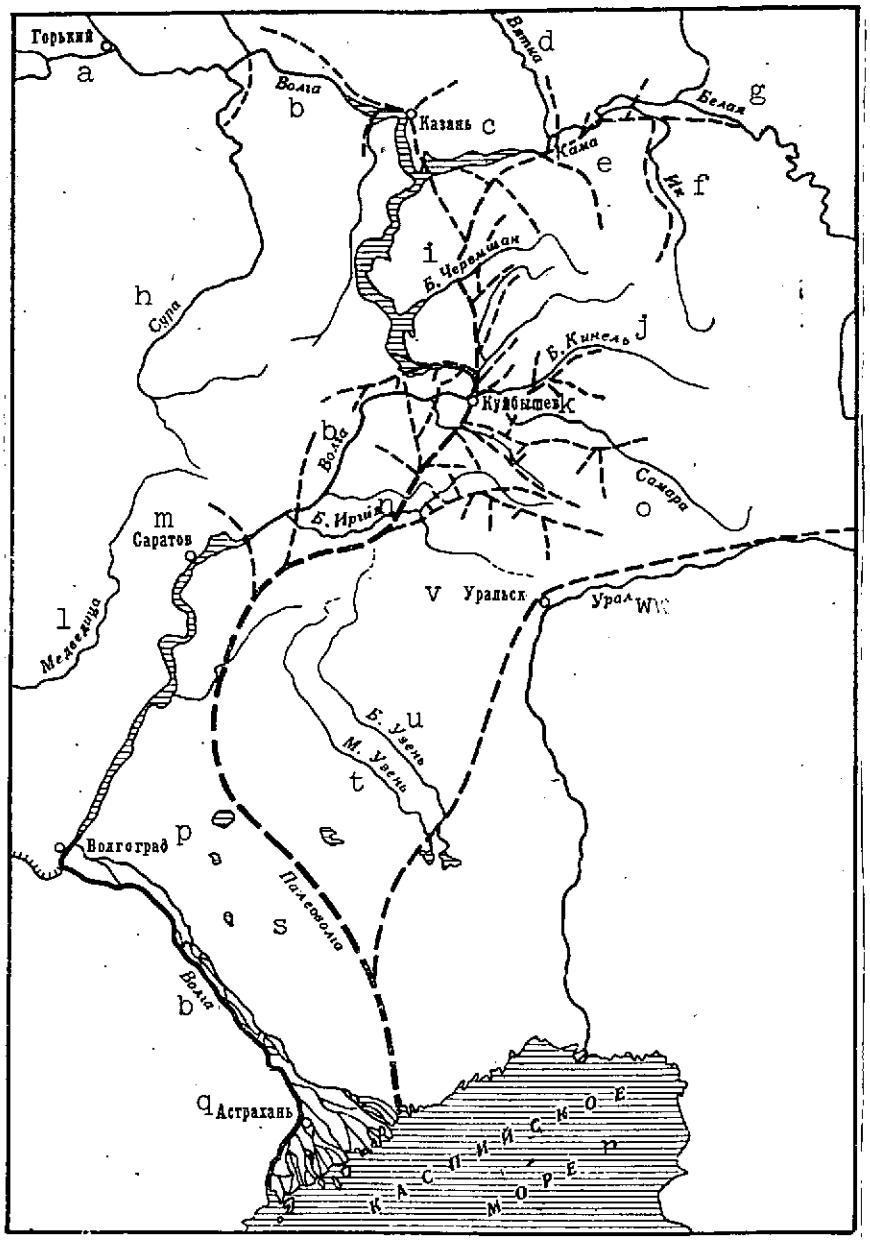
These rearrangements of the river flow in the center of the platform had a long-term nature. Rivers temporarily became tributaries of inland



The Akchagylsk sea (cross hatched), to which sediments from the Russian plain were carried. This marine basin spread broadly over the lands along the Volga and reached the Kama lowlands. Its waves undercut the slopes of the Privolzhe uplands, Yergeni and the northern Caucasus. The Zhigulya were a peninsula. The depression causing such deep penetration of the sea into the Russian plain encompassed the region of the Caspian sea, the Prikaspiskiy syneclise and the Volga depression. Thus, favorable conditions were concentrated here for formation of petroleum. The principal watershed of the Russian plain is shown by a solid line, the Black Sea-Caspian watershed, by a dot-dash line and mountainous regions by the solid black.

seas and lakes. The locations of the river mouths changed in a more complicated and less directed manner, in this case. In the zone of the Moscow syneclise, the thickness of the delta deposits was less significant than in the depressions with more persistent direction of movement. Therefore, the central regions of the Russian platform are of little promise, with respect to being oil-bearing. Towards the southeast, in the direction of the Predkavkazye and Caspian Sea, along the Dnepr-Donets, Ryazan-Saratov and Eastern (Volga) depressions, the rivers flowed for a prolonged period of time, during all continental periods of the "life" of the Russian platform. There are nodes of oil shows here, and it is not surprising that more and more new deposits are being discovered just here.

Paleogeographic maps for different geological periods are enlarging the possibilities of exploration for, and prediction of, oil and gas. However, it must be noted that modern rivers carry the energy necessary for



Modern and Pliocene hydrographic networks of the Volga lands. The channel of the pre-Akchagylsk Paleovolga (heavy dashedline) coincides with the Volga only in the Zhigulya gateways, north of Kuibishev. In the remaining sections, it has been discovered on the left bank of the Volga, 80-100 km from the modern river. Tributaries of the modern Volga and Kama (light dashed lines) duplicate the direction of the paleoriver. The ancient Ural, flowing into the Paleovolga in the Pliocene, changed its flow sharply (medium dashed line). The northern Zhigulya River does not exist at present; it yielded its bed to the Volga, which washed the northern slopes of the Samara bow. With these exceptions, the locations of the modern rivers are remarkably similar to the water network of Pliocene times.

[Key on following page]

Key to figure, p. 19

a. Gor'kiy
b. Volga
c. Kazan'
d. Vyatka
e. Kama
f. Ik
g. Belaya
h. Sura
i. Bol'shoy Cheremshan
j. Bol'shoy Kinel'
k. Kuibishev
l. Medveditsa
m. Saratov
n. Bol'shoy Irguz
o. Samara
p. Volgograd
q. Astrakhan
r. Caspian Sea
s. Paleovolga
t. Malyy Uzen'
u. Bol'shoy Uzen'
v. Ural'sk
w. Ural

---

creating potentially oil-producing rock. Time and mass of sediments limit prediction of future oil formation. The bottoms of valleys filled with Quaternary age alluvium are up to 90-120 m below sea level in the Russian plain. River deltas have moved within the river valleys: in the Pliocene alone, the Paleovolga delta migrated 2000 km, from the Apsheronskiy peninsula to the mouth of the Kama. In this expanse, seven deltas were noted for Quaternary time and it is precisely the locations of the deltas which are characterized by the fixed accumulations of sediments. /37
During subsequent sinking of the alluvial-delta deposits to depths, the temperatures of which can provide for conversion of biogenic sediments into petroleum, they became oil-bearing.

Thus, the process of accumulation of promising oil sediments continues. The modern Volga is carrying a huge amount of alluvium,

containing biological particles, prospective raw material for the formation of oil, to the delta and the shallow water of the northern Caspian. Besides, it must be stipulated: it has carried, and not it is carrying. The regulated state of the flow of the Volga, by means of the building of a cascade of reservoirs, having disrupted the inundation process, has led, not only to loss of the most fertile agricultural lands, but it has considerably reduced the transport of sediments to the delta. Thereby, man, intervening in the natural processes, has modified the natural process of lithogenesis, and, consequently, he has interrupted a single link of the oil formation process connected with it. Disruption of natural processes leads to irreversible changes and loss of natural resources. We must build predictions of the consequences of these changes over a prolonged period of time, at least over many generations.

REFERENCES

1. Obediyentova, G.V., Proiskhozhdeniye Zhigulevskoy vozvyshennosti i razvitiye yeye rel'yefa [Origin of the Zhigulya Hills and Development of Its Relief], "AN SSSR" Press, 1953.

2. Obediyentova, G.V., "Pre-Akchagylsk channel of the Volga," Izvestiya AN SSSR, seriya geograf. (6) (1956).

3. Baturin, V.P., Paleogeografiya po terrigennym komponentam [Paleogeography According to Terrigene Components], Baku, 1937.

4. Shatskiy, N.S., "Deep dislocations encompassing platforms and gently folded regions (lands along the Volga and the Caucasus)," Izvestiya AN SSSR, seriya geolog. (5) (1948).

5. Lichkov, B.L., "Rivers and the genesis of caustobioliths," Tr. Geomorfologicheskogo instituta, Leningrad, "AN SSSR" Press (10) (1934).

6. Markovskiy, N.I., "Role of paleorivers in formation of gas and oil strata (with the example of the lower Carboniferous of the Russian platform)," Izvestiya AN SSSR, seriya geolog. (2) (1965).

7. Lichkov, B.L., "Epirogenetic movements on the Russian plain," Tr. Geomorfologicheskogo instituta, Leningrad, "AN SSSR" Press, 56 (1934).